

## CLAIMS

What is claimed is:

1. A method, comprising:
  - downconverting a beam of coherent energy to provide a beam of multi-color entangled photons;
  - converging two spatially resolved portions of the beam of multi-color entangled photons into a converged multi-color entangled photon beam;
  - transforming at least a portion of the converged multi-color entangled photon beam by interaction with a sample to generate an entangle photon specimen beam; and
  - combining the entangled photon specimen beam with an entangled photon reference beam within a single beamsplitter.
2. The method of claim 1, wherein the entangled photon specimen beam and the reference beam are combined within a single interference zone within the single beam splitter.
3. The method of claim 1, further comprising adjusting a reference beam phase of the entangled photon reference beam before combining.
4. The method of claim 1, further comprising adjusting a specimen beam phase of the entangled photon specimen beam before combining.
5. The method of claim 4, wherein adjusting the specimen beam phase includes retarding the specimen beam phase with a tunable phase adjuster.
6. The method of claim 1, wherein transforming includes:
  - diverting the specimen beam to a beam splitter; and
  - reflecting at least a portion of the specimen beam from the specimen.

7. The method of claim 6, wherein transforming includes redirecting the specimen beam back to an original path.
8. The method of claim 1, further comprising characterizing the sample by detecting a fringe cycle.
9. A computer program, comprising computer or machine readable program elements translatable for implementing the method of claim 1.
10. An electromagnetic waveform produced by the method of claim 1.
11. An electronic medium, comprising a program for performing the method of claim 1.
12. An apparatus, comprising:  
a multi-refracting device providing a beam of multi-color entangled photons;  
a condenser device optically coupled to the multi-refracting device, the condenser device converging two spatially resolved portions of the beam of multi-color entangled photons into a converged multi-color entangled photon beam;  
a beam probe director and specimen assembly optically coupled to the condenser device; and  
a beam splitter optically coupled to the beam probe director and specimen assembly, the beam splitter combining an entangled photon specimen beam from the beam probe director and specimen assembly with an entangled photon reference beam.
13. The apparatus of claim 12, wherein the multi-refracting crystal includes a non-linear crystal.
14. The apparatus of claim 13, wherein the non-linear crystal includes a bi-refracting crystal.

15. The apparatus of claim 13, wherein the non-linear optical crystal includes at least one member selected from the group consisting of LiB<sub>3</sub>O<sub>5</sub>, KH<sub>2</sub>PO<sub>4</sub>, KD<sub>2</sub>PO<sub>4</sub>, NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>,  $\beta$ -BaB<sub>2</sub>O<sub>4</sub>, LiIO<sub>3</sub>, KTiOPO<sub>4</sub>, LiNbO<sub>3</sub>, KnbO<sub>3</sub>, AgGaS<sub>2</sub>, ZnGeP<sub>2</sub>, KB<sub>5</sub>O<sub>8</sub> – 4H<sub>2</sub>O, CO(NH<sub>2</sub>)<sub>2</sub>, CsH<sub>2</sub>AsO<sub>4</sub>, CsD<sub>2</sub>AsO<sub>4</sub>, KTiOAsO<sub>4</sub>, MgO : LiNbO<sub>3</sub>, Ag<sub>3</sub>AsS<sub>3</sub>, GaSe, AgGaSe<sub>2</sub>, CdSe, CdGeAs<sub>2</sub>, KB<sub>5</sub>O<sub>8</sub> – 4D<sub>2</sub>O, CsB<sub>3</sub>O<sub>5</sub>, BeSO<sub>4</sub> – 4D<sub>2</sub>O, MgBaF<sub>4</sub>, NH<sub>4</sub>D<sub>2</sub>PO<sub>4</sub>, RbH<sub>2</sub>Po<sub>4</sub>, RbD<sub>2</sub>PO<sub>4</sub>, KH<sub>2</sub>AsO<sub>4</sub>, NH<sub>4</sub>H<sub>2</sub>AsO<sub>4</sub>, NH<sub>4</sub>D<sub>2</sub>AsO<sub>4</sub>, RbH<sub>2</sub>AsO<sub>4</sub>, RbD<sub>2</sub>AsO<sub>4</sub>, LiCOOH – H<sub>2</sub>O, NaCOOH, Ba(COOH)<sub>2</sub>, Sr(COOH)<sub>2</sub>, Sr(COOH)<sub>2</sub> · 2H<sub>2</sub>O, LiGaO<sub>2</sub>,  $\alpha$ -HIO<sub>3</sub>, K<sub>2</sub>La(NO<sub>3</sub>)<sub>5</sub> · 2H<sub>2</sub>O, CsTiOAsO<sub>4</sub>, NaNO<sub>2</sub>, Ba<sub>2</sub>NaNb<sub>5</sub>O<sub>15</sub>, K<sub>2</sub>Ce(NO<sub>3</sub>)<sub>5</sub> · 2H<sub>2</sub>O, K<sub>3</sub>Li<sub>2</sub>Nb<sub>5</sub>O<sub>15</sub>, HgGa<sub>2</sub>S<sub>4</sub>, HgS, Ag<sub>3</sub>SbS<sub>3</sub>, Se, Tl<sub>3</sub>AsS<sub>3</sub>, Te, C<sub>12</sub>H<sub>22</sub>O<sub>11</sub>, L-Arginine Phosphate Monohydrate, Deuterated L-Arginine Phosphate Monohydrate, L-Pyrrolidone-2-Carboxylic Acid, CaC<sub>4</sub>H<sub>4</sub>O<sub>6</sub> · 4H<sub>2</sub>O, (NH<sub>4</sub>)<sub>2</sub>C<sub>2</sub>O<sub>4</sub> · H<sub>2</sub>O, m-Bis(amonimethyl)benzene, 3-Methoxy-4hydroxy-benzaldehyde, 2-Furyl Methacrylic Anhydride, 3-Methyl-4-nitropyridine-1-oxide, Thienylchalcone, 5-Nitouracil, 2-(N-Prolinol-5-nitropyridine), 2-Cyclooctylamino-5-nitropyridine, L-N-(5-Nitro-2-pyridyl) leucinol, C<sub>6</sub>H<sub>4</sub>(NO<sub>2</sub>)<sub>2</sub> (m-Dinitrobenzene), 4-(N,N-Dimethylamino)-3-acetaminonitrobenzene, Methyl-(2,4-dinitrophenyl)-aminopropanoate, m-Nitroaniline, N-(4-Nitrophenyl-N-methylaminoacetonitrile, N-(4-Nitrophenyl)-L-prolinol, 3-Methyl-4-methoxy-4-nitrostilbene, and  $\alpha$ -SiO<sub>2</sub>.

16. The apparatus of claim 12, further comprising a laser optically coupled to the multi-refringent device.

17. The apparatus of claim 16, further comprising a focusing lens optically coupled between the laser and the multi-refringent device.

18. The apparatus of claim 12, further comprising a first energy-position defining slit optically coupled to the beam splitter, and a second energy-position defining slit optically coupled to the beam splitter.

19. The apparatus of claim 18, further comprising a first detector array optically coupled to the first energy-position defining slit, and a second detector array optically coupled to the

second energy-position defining slit.

20. An optical microscope, comprising the apparatus of claim 12.